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# A METHOD OF MANUFACTURING REFRACTORY MATERIALS
Patent Application

Keisuke Shimizu

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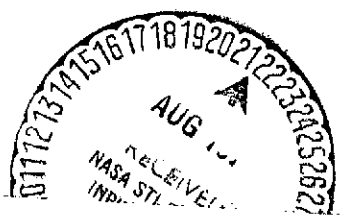


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16. Abstract

A patent applied for by the inventors Keisuke Shimizu, Kiichi Suzuki, and Ikuo Miyajima for a method of manufacturing refractory materials suitable for use as building materials, particularly internal paneling materials. Synthetic resin fiber cloth is impregnated with an alkali silicate; this is dried at 150-300°C and dried while permitting a certain amount of foaming, and refractory materials with a moisture content of more than 75 wt-% with respect to the alkali silicate are manufactured. Sheets of these refractory materials have good machinability and will not crack or warp. When exposed to heat or flames of more than 140°C, the nonwoven cloth will melt, and the alkali silicates also will melt before foaming.

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Patent Application, October 15, 1971

To Director of Patent Agency Takehisa Izuchi

| | |
|---|---|
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*Numbers in the margin indicate pagination in the foreign text.

Detailed Description (1)

1. Name of Invention

A method of manufacturing refractory materials.

2. Range of Patent Claim

A method of manufacturing refractory materials characterized by the fact that synthetic resin fiber cloth is impregnated with an alkali silicate, this is dried at 150-300°C and dried while permitting a certain amount of foaming, and refractory materials containing a moisture content of more than 75 wt-% with respect to the aforementioned alkali silicate are manufactured.

3. Detailed Description of the Invention

This invention pertains to a method of manufacturing refractory materials for use as building materials, particularly internal paneling materials. These refractory materials consist chiefly of an alkali silicate and have fire-proof and smoke-proof properties, foaming in reaction to heat and flames.

The methods known previously for obtaining refractory materials of this type involved impregnating glass fibers, rock wool, or other inorganic fibers with an alkali silicate and drying them to obtain refractory materials in sheet form. In this method, since the inorganic fibers are composed by the coupling of chain-shaped $SiO_2$ molecules, when these inorganic fibers are impregnated with alkali silicates, they will be chemically coupled together to form an integral whole. Rather than being fibrous, they will be in the form of an integral block of silicates from the very beginning and will not have the functions of reinforced fibers. Furthermore, changes will occur, as a result of the chemical coupling, in the concentration of the impregnated alkali silicate. Dehydration will proceed gradually, beginning on the surface,

leading to the drawback that the foaming properties will decline to an extreme degree.

Another method adopted in the past has been that of impregnating inorganic fibers with alkali silicates and then leaving them for a prolonged period of time at normal temperatures to dry, or drying them with temperatures suppressed to below 100°C. In some cases, they are heated to about 150°C and /500 dried in order to shorten the drying time. The sheets obtained by drying in this state have the alkali silicate fixed to the fibers in a rigid state. There are a number of defects. For example, this causes cracking, and the sheets cannot be cut by ordinary woodworking cutting tools. Furthermore, they tend to contract and warp easily.

Thus, the conventional refractories consisting of fibers impregnated with alkali silicates in the past were hardened and had a small foaming quantity. They tended to crack easily when exposed to heat. They were vulnerable to invasion by combustion air, the quantities of smoke generated were great and tended to vary greatly, and they tended to burn easily. They were extremely brittle and had inferior fire-proof properties.

If the total amount of inorganic fibers used was less than 10%, the volume ratio would be low, and there would be a weak mechanical strength due to the fiber construction. If the amount was more than 10%, the foaming effect would be impeded, and it would be impossible to increase the amount of fibers in order to increase the strength. Furthermore, since the inorganic fibers have a melting point of more than 400-500°C, these fibers will retain the same form even when the alkali silicates are in a foaming state (at higher than 100°C). Therefore, the foaming will be inhibited, and almost no foaming at all will occur.

Among the fibers to be impregnated with alkali silicates, organic vegetable fibers or semi-synthetic natural fibers might be considered. However, in these natural fibers, reactions will occur between the carboxyl group in the cellulose of the skeleton molecules and the alkalis in the alkali silicates. This will result in decomposition of the cellulose itself while at the same time it penetrates into the cellulose. This will result in extremely hard sheets and will also lower their foaming function.

Furthermore, when vegetable fibers are exposed to flames, they will be carbonized rather than melting, and this will likewise inhibit the foaming of the sodium silicate, so that almost no foaming will take place (experimental results).

For this reason, when organic vegetable fibers are impregnated with alkali silicates, chemical coupling will occur between the alkali silicates and the fibers, causing solidification and giving poor cutting properties. This will also result in cracking and warping. When exposed to flames, foaming will not occur, but there will be carbonization, and large amounts of smoke will be produced. The sheets will burn easily and will also have inferior refractory functions.

This invention provides refractory materials which retain their suppleness, which will not crack or warp, which will foam reliably in reaction to heat or flames, and which have superior refractory properties. The refractory materials are manufactured by impregnating synthetic resin fiber cloth with alkali silicates. They are heated to temperatures of 150-300°C and dried rapidly while permitting a certain amount of foaming. The moisture content is more than 75% with respect to the aforementioned alkali silicates.

Next let us describe an example of the application of this invention. Nonwoven cloth of synthetic resin fiber such as polyesters, polypropylene, or vinyl chloride is impregnated with alkali silicates. The contents of this nonwoven cloth with respect to the alkali silicates are approximately 10%. This nonwoven cloth impregnated with alkali silicates is then heated with hot air at about 300°C for 20-30 minutes, allowing some foaming of the alkali silicates, in order to give a moisture content of more than 75% with respect to the alkali silicates. This is then formed into refractory materials of a smooth sheet shape on hot rolls.

Since in this invention nonwoven cloth of organic synthetic fibers is impregnated with alkali silicates, the fibers are cloth-like fibers in which the fibers are coupled to each other by a binder. As a whole, therefore, the fibers are bonded /501
strongly together, and at the normal state the sheet-like refractory materials are given a mesh-like reinforcement effect. Therefore, they have a great impact strength.

Since hydrophobic organic synthetic fibers are used in this nonwoven cloth, they are chemically inert in relation to the alkali silicates with which they are to be impregnated, and chemical coupling does not occur between them. Even in the dry state, they will maintain the shape of reinforced fibers and will have a stress relaxation function with respect to bnding impacts. Furthermore, since chemical coupling does not take place with the nonwoven cloth, there are no changes in the ratio between the alkali and the silicate in the alkali silicates. If suitable protective methods are taken on the outside, a dehydration reaction will not occur, there will be no changes in the moisture content of the refractory materials, and the foaming functions of the alkali silicates will be maintained so that they will foam in reaction to heat and flames.

Furthermore, since the nonwoven cloth of these refractory materials consists of synthetic resin, it will melt when exposed to heat or flames of 100-250°C and will therefore not impede the foaming of the alkali silicates. Since these refractory materials have a moisture content of more than 75% with respect to the alkali silicates, the insulating foaming layer will be thick, and an alkali silicate insulating layer will be formed without concomitant smoking. That is, since the synthetic resin fibers of organic high polymers are wrapped in alkali silicate foam, the only reaction to flame will be melting, and decomposition will occur after an extremely long period of time in comparison with the normal state. Therefore, the foaming insulating layer will be formed without any smoke generation. The aforementioned facts were ascertained as a result of experiments.

Therefore, in order to increase the mechanical strength, it is possible to increase the weight content of the nonwoven cloth in the refractory materials. In addition, these organic synthetic fibers are quite light, their specific gravity being less than one-half that of inorganic fibers. Even though the weight content is identical, they have a greater reinforcing effect than inorganic fibers.

As a result, there are no particular limitations on the weight content of the nonwoven cloth, which can be contained in suitable percentages in order to obtain the prescribed strength.

Furthermore, drying is performed rapidly in a high-temperature atmosphere of 150-300°C while allowing some foaming at high temperatures. Therefore, even though during drying they are exposed to temperatures higher than the melting point

of the organic synthetic fibers, there is naturally no melting and flashing, as one would expect from common-sense considerations in physics. Besides, there is no chemical coupling between the nonwoven cloth and the alkali silicates, as was mentioned above, and there are bending properties. It is believed that this is attributable to the fact that optical microscopic microvoids are present on the fiber surfaces and between the fibers during drying, and that they function to relax the stress between the fibers at the normal state.

Consequently, the alkali silicates are impregnated between the nonwoven cloth fibers but do not penetrate inside the fibers. There is little moisture content, and the cutting properties are good. The sheets can be machined as easily as wood, and retain their suppleness. Cracking and warping will not occur. When exposed to heat or flames of more than 140°C, the nonwoven cloth will melt, and the alkali silicates will also melt before foaming. They will both fill up the voids, and the penetration of air will be prevented by the synergistic action of both. Firm coupling will result from the foaming of the alkali silicates, and there will be no invasion of the air. Even though carbonization may occur after prolonged exposure to flames, no smoke will be produced. The materials have superior refractory properties and are especially outstanding when used as refractory interior paneling materials for the inside of buildings.

Example of Application

Nonwoven cloth of 1 $m^2$ 60 g organic synthetic resin fibers is impregnated with 1.8 kg of sodium silicate, and the fiber quantity is 0.083.

A ratio of 40 sodium silicate and 60 water is adopted for 1 $m^2$, and 1.8 kg of nonwoven cloth is impregnated with this. During drying, 30% of the moisture is evaporated so that the moisture content will be 75% or more with respect to 100 of the sodium silicate impregnating liquid. /502

October 15, 1971

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5. List of Attached Papers

(1) One (1) detailed description

~~(2) One (1) reply~~

(3) One (1) letter of attorney

(4) One (1) copy of application

(5) One (1) request for investigation of application

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